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10/684,278	10/11/2003	Raymond G. Beausoleil	200311663-1	3329

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EXAMINER	
CONNELLY CUSHWA, MICHELLE R	
ART UNIT	**PAPER NUMBER**
2874	

DATE MAILED: 05/09/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

H·A

Office Action Summary	Application No.	Applicant(s)	
	10/684,278	BEAUSOLEIL ET AL.	
	Examiner	Art Unit	
	Michelle R. Connelly-Cushwa	2874	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-6,17-19 and 40-58* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-6,17-19 and 40-58* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *11 October 2003 and 14 September 2005* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *9/28/05*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

Applicant's election without traverse of Group I, claims 1-6 and 17-19 in the reply filed on September 14, 2005 is acknowledged.

Information Disclosure Statement

The prior art documents submitted by applicant in the Information Disclosure Statement filed on September 25, 2005 have all been considered and made of record (note the attached copy of form PTO-1449).

Drawings

Eight (8) sheets of drawings were filed on October 11, 2003.

Three (3) replacement sheets of drawings were filed on September 14, 2005.

Sheets 2, 4, 5, 7 and 8 filed on October 11, 2003 and Replacement sheets 1, 3 and 6 filed September 14, 2005 have been accepted by the Examiner.

Specification

Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 17-19 and 40 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Regarding claim 17; the claim recites the limitation "an electrical element adjacent *the defect*" in line 6 of the claim. This limitation is unclear because the claim has previously defined "a line defect" in line 4 of the claim and "a point defect" in line 5 of the claim, and it is impossible to tell which of the line and point defects the limitation in question refers to. The Examiner suggests changing "the defect" in line 6 of the claim to either –the line defect—or –the point defect—in order to clarify which defect the electrical element is adjacent to.

Regarding claim 19; the claim recites the limitation "the defect" in line 2 of the claim. It is unclear whether this limitation refers to either the line defect or the point defect previously defined in base claim 17.

Regarding claims 18, 19 and 40; the claims inherently contain the deficiencies of any base or intervening claims from which they depend.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1 and 2 are rejected under 35 U.S.C. 102(b) as being anticipated by Horst et al. (US 4,941,205).

Regarding claims 1 and 2; Horst et al. discloses an interconnect system (see Figure 2) comprising:

- a first circuit unit (First Data Unit, 31) containing a first modulator (27, modulated optical source) capable of modulating a first optical signal (modulated light, 53) output from the first circuit unit (31); and
- a second circuit unit (Second Data Unit, 33) containing a first detector (optical detector, 45) capable of detecting modulation of the first optical signal to extract a first information stream (data);
- wherein the second circuit unit (33) further comprises a second modulator (optical modulator, 47) capable of modulating a second optical signal; and
- wherein the first circuit unit (31) further comprises a second detector (optical detector, 41) capable of detecting modulation of the second optical signal to extract a second information stream.

Claims 17 and 18 are rejected under 35 U.S.C. 102(b) as being anticipated by Koops et al. (US 6,310,991 B1).

Regarding claims 17 and 18; Koops et al. discloses an interface for input/output from an integrated circuit (see the title and abstract) in Figure 6, comprising:

- a photonic bandgap crystal (see column 3, lines 42-45);
- a line defect in the photonic bandgap crystal (the line defect forms the waveguides);

- a point defect within the photonic bandgap crystal (the point defects form the filter, 43, and the phase shifter, 45); and
- an electrical element (46, 47, 48, 49) adjacent the defect;
- wherein the electrical element (46, 47, 48, 49) comprises an electrode adjacent the point defect; and
- wherein the point defect acts as a resonator for a wavelength of an optical signal and has an optical property that varies with a voltage applied to the electrode (see column 3, lines 54-59).

Claims 17 and 18 are rejected under 35 U.S.C. 102(e) as being anticipated by Fan (US 2003/0142719 A1).

Regarding claims 17 and 18; Fan discloses an interface for input/output from an integrated circuit (see Figure 3), comprising:

- a photonic bandgap crystal (30);
- a line defect (12') in the photonic bandgap crystal;
- a point defect (14') within the photonic bandgap crystal; and
- an electrical element (electrode; see paragraph [0047]) adjacent the defect;
- wherein the electrical element comprises an electrode adjacent the point defect; and
- wherein the point defect acts as a resonator for a wavelength of an optical signal and has an optical property that varies with a voltage applied to the electrode (see paragraph [0047]).

Claims 17, 19, 40 and 51-57 are rejected under 35 U.S.C. 102(b) as being anticipated by Noda et al. (US 2002/0009277 A1).

Regarding claims 17 and 19; Noda et al. discloses an interface for input/output from an integrated circuit (see Figures 1 and 8), comprising:

- a photonic bandgap crystal (see paragraph [0051]);
- a line defect (12) in the photonic bandgap crystal;
- a point defect (14) within the photonic bandgap crystal; and
- an electrical element (photodiodes 45-47, see Figure 8 and paragraph [0065]) adjacent the defect;
- wherein the electrical element (45-47) comprises a photodiode within the defect.

Regarding claim 40; Noda et al. further teaches that the interface may comprise a plurality of point defects (21, 22; see Figures 2 and 7) within the bandgap crystal and adjacent to the line defect (12), wherein each of the point defects acts as a drop filter for a different frequency of light (λi, λj).

Regarding claims 51-56; Noda et al. discloses an interface of an integrated circuit (see Figure 2), comprising:

- a waveguide (line defect, 12, forms a waveguide) for an optical signal (23) that includes a plurality of frequency components ($\lambda 1$, $\lambda 2$,... λi, λj);
- a plurality of resonators (point defects, 21 and 22) adjacent to the waveguide (line defect, 12), wherein the resonators respectively

correspond to frequency components, and each of the resonators provides a path for a corresponding frequency component; and

- a plurality of electrical elements (photodiodes, 45, 46 and 47; see Figure 8) respectively associated with the resonators;
- wherein the interface comprises a photonic bandgap crystal.

Regarding claim 57; Noda et al. further discloses that each of the resonators (point defects) may optionally feed the corresponding frequency components into the waveguide (see paragraph [0059]) in order to form a multiplexer.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Horst et al. (US 4,941,205) in view of Scherer (US 6,804,283 B2) and Pearsall (US 2004/0150873 A1).

Regarding claim 3; Horst et al. discloses the general configuration of an interconnect system as required by the claims of the present application, but does not teach that the first circuit unit comprises a photonic bandgap crystal, wherein the first modulator comprises a first defect within the photonic bandgap crystal and en electrode adjacent the first defect.

Scherer teaches that photonic crystals provide compact, flexible platforms for connecting and/or forming optical sources, detectors, modulators, routers, polarizers and/or filters in compact microfabricated systems having precise, electrically tunable spectral responses (see the abstract; column 1, line 15, through column 2, line 64; column 4, lines 52-59; and column 5, lines 19-67) that may be advantageously employed in a monolithic platform that provides efficient guiding of light between many nano-photonic devices. It is generally known in the art that monolithic devices have reduced size and achieve good alignment, thereby lowering optical loss. Therefore, one of ordinary skill in the art would have recognized the advantages of forming an optical circuit unit that includes waveguides, optical sources, detectors, modulators, routers, polarizers and/or filters from a photonic crystal in any optical system, including the system having the layout disclosed by Horst et al. Thus, one of ordinary skill in the art would have found it obvious to form the first circuit unit of Horst et al. with a photonic

crystal to provide a compact circuit with a precise, electrically tunable spectral response that is monolithically formed.

Pearsall discloses a high-speed optical modulator comprising a first defect within a photonic bandgap crystal and an electrode adjacent to the first defect, wherein the first defect acts as a resonator for a wavelength of the first optical signal and has an optical property that varies with a voltage applied to the electrode (see the abstract and paragraphs [0042]-[0043]). One of ordinary skill in the art would have found it obvious to form the first circuit unit and first modulator from a photonic bandgap crystal, given the teachings of Scherer, and would further have found it obvious to form the modulator with a first defect, wherein the first defect acts as a resonator for a wavelength of the first optical signal and has an optical property that varies with a voltage applied to the electrode in order to form a high-speed modulator with the photonic band-gap crystal, in accordance with the teachings of Pearsall.

Claims 4 and 46-49 are rejected under 35 U.S.C. 103(a) as being unpatentable over Horst et al. (US 4,941,205) in view of Scherer (US 6,804,283 B2) and Noda et al. (US 2002/0009277 A1).

Regarding claims 4 and 46-49; Horst et al. discloses the general configuration of an interconnect system as required by the claims of the present application, but does not teach the specifics of these claims.

Scherer teaches that photonic crystals provide compact, flexible platforms for connecting and/or forming waveguides, routers and/or detectors in compact microfabricated systems having precise, electrically tunable spectral responses (see the

abstract; column 1, line 15, through column 2, line 64; column 4, lines 52-59; and column 5, lines 19-67). Therefore, one of ordinary skill in the art would have recognized the advantages of forming an optical detector, waveguide and/or router in any optical system, including the system having the layout disclosed by Horst et al., from a photonic crystal. Thus, one of ordinary skill in the art would have found it obvious to form the first detector and/or optical circuit of Horst et al. from a photonic crystal.

Noda et al. discloses an interface for input/output from an integrated circuit (see Figures 1 and 8), comprising a photodiode (45-47) at a point defect within a photonic bandgap crystal (see paragraph [0051]), wherein the defect acts as a resonator for a wavelength of the optical signal. Therefore, one of ordinary skill in the art would have found it obvious to incorporate a first detector comprising a photodiode at a defect within a photonic bandgap crystal, wherein the defect acts as a resonator for a wavelength of the optical signal in the system layout disclosed by Horst et al. to provide a detector with a precise electrically tunable spectral response.

The circuit of Noda includes a photonic bandgap crystal containing a waveguide for an optical signal, a plurality of defects (see Figures 2, 7 and 8), wherein each of the defects acts as a drop filter for a different wavelength of light; and a plurality of detectors (45-47; see Figure 8) respectively associated with the plurality of defects, wherein each detector generates an electrical signal that inherently indicates any modulation of a light signal extracted by the associated defect. Given the disclosures of Horst et a., Scherer, and Noda et al., one of ordinary skill in the art would have found it obvious to form the second circuit in the layout disclosed by Horst et al. with a photonic bandgap crystal

containing a waveguide, a plurality of defects, wherein each of the defects acts as a drop filter for a different wavelength of light, and a plurality of detectors respectively associated with the plurality of defects, wherein each detector generates and electrical signal that indicates a modulation of a light signal extracted by the associated defect in accordance with the teachings of Noda et al. and Scherer in order to be able to detect multiple wavelengths individually from a multiplexed signal.

Given the suggestions of Scherer to provide nonlinear polymers at the defects and electrodes at the associated defects to modulate or fine-tune the response of the defects that form filters (see column 5, line 19, through column 6, line 56), one of ordinary skill in the art would have found it obvious to provide non-linear optical material in the defects in the photonic crystal structure disclosed by Noda et al. and to provide associated electrodes with the defects to electrically tune the filters formed by the defects, to modulate the signals as desired, wherein the modulators are responsive to electrical signals. Also, given the teachings of Noda et al. that second waveguides (35-37; see Figure 7) may be coupled to the defects to receive the demultiplexed wavelengths, one of ordinary skill in the art would have found it obvious to couple second waveguides to the defects to receive the wavelengths in order to provide a means to further guide and/or direct the demultiplexed signals to a desired location.

Claims 5 and 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Horst et al. (US 4,941,205).

Regarding claim 5; it is generally within the level of ordinary skill in the art to form an optical circuit on a substrate, chip or carrier in order to provide a platform on which to

form the circuit and to maintain the positional relationship between the various elements of the circuit. Therefore, one of ordinary skill in the art would have found it obvious to form the first circuit unit on a first chip and to form the second circuit unit on a second chip, since this is very elementary and within the level of ordinary skill in the art.

Regarding claim 6; it is generally within the level of ordinary skill in the art to incorporate either an external source to supply an optical signal to a circuit chip or an integrated source to supply an optical signal to a circuit chip, and one of ordinary skill in the art would have found it obvious to do either in the invention of Horst et al., since it appears that the invention would perform equally well regardless.

Claims 41-45 and 50 are rejected under 35 U.S.C. 103(a) as being unpatentable over Horst et al. (US 4,941,205) in view of Scherer (US 6,804,283 B2), Pearsall (US 2004/0150873 A1), and Noda et al. (US 2002/0009277 A1).

Regarding claims 41-43; the references applied above teach or suggest all of the limitations of claims 41-43, except for the first circuit unit further comprising a second defect that acts as a waveguide for the first optical signal in the photonic bandgap crystal, the first defect being adjacent to the second defect. Given the suggestion of Scherer to form a circuit with waveguides or routers from photonic bandgap crystals, and the knowledge of photonic bandgap crystals that one of ordinary skill in the art would possess, one of ordinary skill in the art would have found it obvious to form an optical waveguide in the photonic bandgap crystal circuit to guide the light from the modulator to an output of the circuit. Noda et al. discloses a photonic bandgap crystal waveguide formed by a line defect (12) that is adjacent to a point defect (14) that

operates as a modulator by extracting and/or introducing a specific wavelength of light from or into the waveguide (see Figure 1). Therefore, one of ordinary skill in the art would have found it obvious to further include a second defect that acts as a waveguide for the first optical signal in the photonic bandgap crystal, the first defect being adjacent to the second defect, in the manner taught by Noda et al. in order to efficiently and precisely guide the light in the first circuit unit.

Regarding claim 44; one of ordinary skill in the art would have found it obvious to incorporate a photonic bandgap crystal containing a plurality of defects, wherein each of the defects acts as a resonator for a different wavelength of light, as suggested by Figure 2 of Noda et al., in order to multiplex and/or demultiplex the light, and a material in each of the defects that has a refractive index that depends on an electric field in the material, as suggested by Scherer (see column 5, line 19, through column 6, line 56); and a plurality of electrodes respectively adjacent to the plurality of defects, wherein an electrical signal applied to one of the electrodes changes the electric field in an corresponding one of the defects in order to individually tune each of the defects to achieve the desired transmission and/or reception results.

Regarding claim 45; the proposed combination of references suggests all of the limitations of claim 45 as applied above, except for specifically stating that the material in the point defect comprises lithium niobate. However, lithium niobate is well known, is commonly used as an electro-optic material in the art, and is readily available. Therefore, one of ordinary skill in the art would have found it obvious to use lithium

niobate as the non-linear optical material that is used to electrically tune the point defects.

Regarding claim 50; each of the detectors disclosed by Noda et al. (45-47; see Figure 8) generates an electrical signal that inherently indicates any modulation of the frequency component that the corresponding drop filter extracts from the waveguide, and Horst et al. teaches that the signals are modulated.

Claim 58 is rejected under 35 U.S.C. 103(a) as being unpatentable over Noda et al. (US 2002/0009277 A1) in view of Pearsall (US 2004/0150873 A1).

Regarding claim 58; Noda et al. discloses all of the limitations of claim 58 as applied above, except for each of the electronic elements comprising a modulator that modulates the frequency components that the associated resonator feeds into the waveguide. Pearsall teaches that electronic elements can be provided adjacent to point defects in photonic crystals to modulate the frequency response of the point defect. One of ordinary skill in the art would have found it obvious to provided electronic elements adjacent to the point defects in the invention of Noda et al. to modulate the frequency response of the point defects to thereby fine-tune the multiplexed and/or demultiplexed wavelengths as desired.

Conclusion

Any inquiry concerning the merits of this communication should be directed to Examiner Michelle R. Connelly-Cushwa at telephone number (571) 272-2345. The examiner can normally be reached 9:00 AM to 7:00 PM, Monday-Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Rodney B. Bovernick can be reached on (571) 272-2344. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Any inquiry of a general or clerical nature should be directed to the Technology Center 2800 receptionist at telephone number (571) 272-1562.

Michelle R. Connelly-Cushwa
Patent Examiner
May 5, 2006